PIC BASED HAND-HELD IC TESTER

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Electronics)"

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ABSTRACT

Nowadays, electrical devices are very common in our life, for example televisions, computers, cellular phones, remote control, automobile etc. All the electrical devices consist of integrated circuits (ICs). As the FKEE students, dealing with ICs has become a norm. However, the IC tester used in laboratory to verify the availability of the ICs is big, not portable, heavy and expensive. Thus, a hand-held IC tester is developed to test common ICs used in the laboratory. In this project, the microcontroller used is PIC18F4525 to control the operation of the system. In addition, it is equipped with a numerical keypad, keypad encoder, IC socket, liquid crystal display screen, beeper and a 9V cell battery power supply. The ICs to-be-tested will be placed into IC socket. The code of the IC will be keyed in by using the keypad. Then, the outcome of the test will be shown at the LCD screen and beeper to indicate the status of the ICs. The system is compact, portable and can test various forms of 20 pins ICs such as basic logic gate, multiplexer, de-multiplexer, encoder, decoder, counter, flip-flop, and etc.

ABSTRAK

Pada masa kini, peralatan elektrik boleh dijumpa di mana-mana sahaja dalam kehidupan, contohnya televisyen, komputer, telefon bimbit, kenderaan dan sebagainya. Semua alat elektrik mempunyai litar bersepadu (IC). Sebagai pelajar FKEE, litar bersepadu merupakan pekara lazim. Namun, alat penguji IC yg digunapakai dalam makmal adalah besar, berat, mahal dan tidak mudah-alih.. Oleh itu, sebuah alat penguji IC yang mudah-alih telah direka untuk tujuan menguji IC yg digunapakai dalam makmal. Dalam projek ini, mikropengawal yang digunakan untuk mengawal operasi system ini adalah PIC18F4525. Sistem ini terdiri daripada papan kekunci, pengekod papan kekunci, soket IC, skrin paparan LCD, alat penjana nada dan satu sel bateri kering 9V sebagai bekalan kuasa bateri. IC yang hendak diuji akan diletakan dalam soket IC. Nombor IC akan dimasukan dengan menggunakan papan kekunci. Selepas itu, keputusan pengujian IC akan dipaparkan di skrin paparan LCD dan bunyi akan dihasilkan. Sistem ini adalah padat, mudah alih, dan boleh menguji pelbagai jenis IC yang mempunyai 20 pin.

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LIST OF ABBREVIATIONS

DVD	Digital Versatile Disc
IC	Integrated Circuit
PCB	Printed Circuit Board
DIP	Dual Inline Package
SMT	Surface Mount Technology
PLCC	Plastic Leaded Chip Carrier
SSI	Small-scale Integration
MSI	Medium-scale Integration
LSI	Large-scale Integration
VLSI	Very large-scale Integration
ULSI	Ultra large-scale Integration
WSI	Wafer-scale Integration
SOC	System-on-a-chip
ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
MOSFET	Metal-oxide Semiconductor Field-effect Transistor
BJT	Bipolar Junction Transistors
TTL	Transistor-Transistor Logic
CMOS	Complementary Metal-Oxide Semiconductor
UMP	University Malaysia Pahang
PIC	Peripheral Interface Controller
LCD	Liquid Crystal Display
I/O	Input or Output
EEPROM	Electrically Erasable Programmable Read Only Memory
ROM	Read Only Memory
CPU	Center Processing Unit
R/W	Read or Write
RS	Register Select
E	Enable
ZIF	Zero Insertion Force
DA	Data Available

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CHAPTER 1

INTRODUCTION

1.1 Background

Electronic circuits can be divided into two general categories, analog and digital. Analog signal is defined as continuous signal for which the time varying feature of the signal is a representation of some other time varying quantity. For example sound wave and electromagnetic wave. Digital system on the other hand, is the opposite of analog, is defined as discrete or non-continuous system.

Almost everything in the world is represented in analog form. However, digital representation becomes more important in our life due to enormous advantages. First and foremost, the storage capability in digital form, digital versatile disc (DVD) is thousand times larger than analog form, film. Data that is stored in digital form can be copied or reproduced easily, faster and more reliable. The data transmission, computer

arithmetic and machine language uses digital signal. Thus, digital represents the technology.

Integrated circuits (IC) is a miniaturized electronic circuit that has been manufactured in the surface of a thin substrate if semiconductor material such as silicon. The circuit is made up of large quantities of transistors, resistors, capacitors and diodes. Those basic components are combined to form "Logic Gate". Combination of several logic gates formed the ICs. IC and digital are inseparable. IC can be found in any electrical or electronic devices such as television, computer, cellular phones, car, and etc.

Fixed-function digital ICs are classified based on their complexity such as small scale, medium scale, large scale and etc. Table 1.1 shows the detail of generation of IC from the oldest to latest technology.

Table 1.1: Generations of ICs

Names	**No of Transistors**	**Functions**
Small-scale Integration (SSI)	2 to 10	First generation basic logic gates IC
Medium-scale Integration (MSI)	10 to 100	Encoders, Decoders, Counters, Flip-flops, Registers, etc
Large-scale Integration (LSI)	100 to 10,000	1Kbits-RAM, calculator chips, 1st generation microprocessor
Very large-scale Integration (VLSI)	10,000 to 100,000	1Mbits-RAM, 2nd generation microprocessor
Ultra large-scale Integration (ULSI)	>100,000	Further upgrade of memory and microprocessor (Pentium)

Wafer-scale Integration (WSI)	-	Super-chip for super-computer
System-on-a-chip (SOC)	-	Single-chip computers consist of all component of a computer
Three Dimensional Integrated Circuit (3D-IC)	-	2 or more layers connected vertically or horizontally which are saving more energy with optimum speed.
Application-specific Integrated Chip (ASIC)	5000 to >100,000,000	ICs customized for particular use instead of general purpose.

ICs can be classified to three categories, analog, digital and mixed signal. Digital ICs can consist of logic gates, flip-flops, multiplexer and etc in a very small size of it. Digital ICs having the advantages of high speed, low power dissipation, smaller size and reduced manufacturing cost compared with other class. Concept of digital ICs is performing mathematics work about "1" and "0".

All the ICs were formed by using either metal-oxide semiconductor field-effect transistor (MOSFET) or bipolar junction transistors (BJT). MOSFET is controlled by gate voltage with higher input impedance while BJT is controlled by base current with higher input gain. Table 1.2 shows some of the advantages and disadvantages between MOSFET and BJT.

Table 1.2: BJT vs MOSFET

	BJT	MOSFET
Advantages	1. Greater linearity 2. Ease of manufacture	1. Less sensitive to temperature **2. Low power consumption**

	3. Good noise performance 4. Superior in high power applic. **5. High switching speed** 6. High speed integration	3. Smaller size 4. Less noise margin 5. Integrate large and complex circuit with high yield. 6. Slightly slower than BJT for previous technology.
Disadvantages	1. Bigger size 2. Complexity of control current 3. More power dissipated	1. More static sensitive 2. Easy breakdown due to sensitivity.

For TTL family of IC, it is divided into several core parts that differ in various parameters, such as power dissipation, delay times, switching speed, temperature handling and etc. Table 1.3 shows the core part of TTL logic family.

Table 1.3: Core Part of ICs

Designation	Desciption
None	Standard TTL (Stop produce)
L	Low Power
H	High Speed
S	Schottky
LS	Low Power Schottky
AC	FACT Logic (New CMOS Tech.)
ACT	FACT Logic (New CMOS Tech.with TTL Logic)
AS	Advanced Schottky
ALS	Advanced Low Power Schottky
C	CMOS Technology (early version)
HC	High Speed CMOS
HCT	High Speed CMOS with TTL input

There are several types of fault of digital IC such as inputs or outputs are shorted to ground or Vcc, inputs or outputs are open-circuit, pins of ICs are broken, shorted between two pins other than Vcc or ground, failure of basic internal circuitry and etc.

When the inputs or outputs are shorted to ground or Vcc, the shorted pin will receive or show the “1” or “0” along the time. The result is regardless any input given to the shorted pins and vice versa for shorted output pins

Open-circuited input or output pins happen due to very fine conduction wire have broken. The same case happens when the pins of IC are broken but we normally didn’t notice about it. We normally plug-in the digital IC to IC base makes us overlook about the number of pins.

If shorted between a high logic pin with another low logic pin happen, the tri-state condition might occur where the result is neither “1” nor “0”. Besides that, failure of internal circuitry is unpredictable. This problem happens due to overheating IC or reaching the life span of the IC.

The conclusion is, any ICs which not giving the predicted output from truth table are malfunctioning. The IC Tester is best device to detect the failure of IC.

1.2 Development of IC Tester

ICs have strong bond with our life nowadays. Many individuals or organizations are dealing with certain IC which related to their fields. These organizations are ordering a large quantity of ICs for manufacturing. During the manufacturing, packing and delivering process, there might have chances to cause damage to the ICs. All the IC should be tested to verify its functionality so that they can claim back from manufacturer. A device to perform the testing task is called IC tester.

There are no such things called general IC tester in the world especially after VLSI IC is developed. There are personal IC tester for particular IC and normally created by the manufacturer itself. Some organizations may order the IC tester from manufacturer for testing specific IC.

1.2 Objectives

The main objective of this project is to design and develop a portable hand-held IC tester that is capable to test the availability of various simple digital ICs. The IC tester will be able to test some common digital ICs that are used in the laboratories in UMP such as logic ICs, multiplexers, encoders, decoders, latch, counter, flip-flop, etc.

1.3 Scopes

The scopes of this project are to design and develop a hand-held IC tester by using PIC18F4525 as operating system. Keypad and keypad encoder as input modules for users to key-in IC code. Liquid crystal display (LCD) module is used to display the result of testing on screen. Beeper module is used to indicate the status of testing result by producing different tones.

The IC tester can test up to maximum 20 pins of digital IC. Power supply of the IC tester is either 9V cell battery or 9V DC power supply adapter. The IC tester will be light weighted, small size and portable.

1.4 Thesis Outline

The thesis consists of six chapters. Chapter one is the introduction of integrated circuit and IC tester. The objectives and the outline of the project will be elaborated in this chapter

Chapter two describes the overview of the project. It will be a brief review of the hardware and software design. This chapter also will briefly introduce the PIC microcontroller. Theory of IC testing also included in chapter two. Explanation will be based on the theory and conceptual ideas.

Chapter three shows the detail of hardware design of the project. The hardware that involved will be discussed thoroughly. Each type of component is representing by a module. Explanation will be given in a more technical way and specific terms with the help of schematic diagrams.

Chapter four is about software development. The flowchart and programming of each module will be explained in this chapter. The details of software are including IC testing process.

Chapter five is result of testing of each module. Explanation and discussion are based on the result of testing.

Chapter six is the last chapter which concludes the project. The contents included the recommendations and suggestion for future development. Commercialization will be stated in this chapter as well

CHAPTER 2

SYSTEM ARCHITECTURE

2.1 Overview

A handheld IC tester is designed by using and embedded controller, a keypad, a keypad encoder, a liquid crystal display (LCD) and an audible device. This is shown in figure 2.1. The information of the IC is place-in through the keypad. The controller then test the IC based on the truth table or waveform of individual chip. The result of various test are displayed on the LCD.

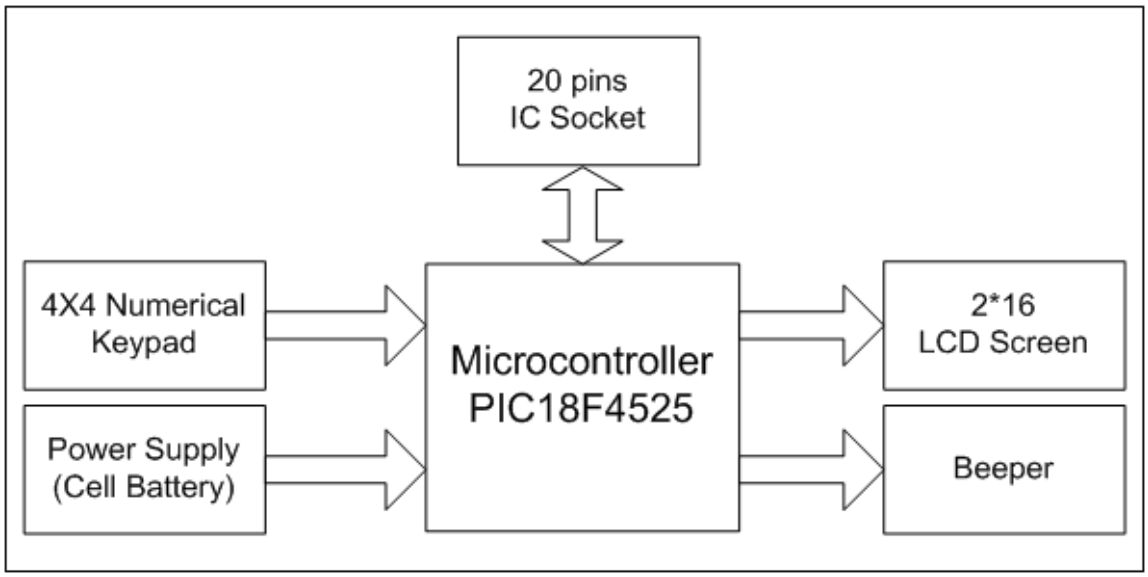

Figure 2.1: Block Diagram of IC Tester

2.2 Microcontroller System Board Module

The microcontroller system or embedded controller plays an important role in the design. It reads the information from the input, evaluate the chip and produce the output to the LCD. There are various type of microcontroller available nowadays with different speed, memory size and features. However, Microchip product of PIC18F4525 is chosen due to large size of memory and EEPROM data memory, extensive I/O port, simple programming and low power consumption.

PIC18F4525 required only power module to operate functionally because the internal oscillator is provided. In order to activate the internal oscillator tuning register (OSCTUNE) need to be initialized. Figure 2.2 shows the microcontroller system board.

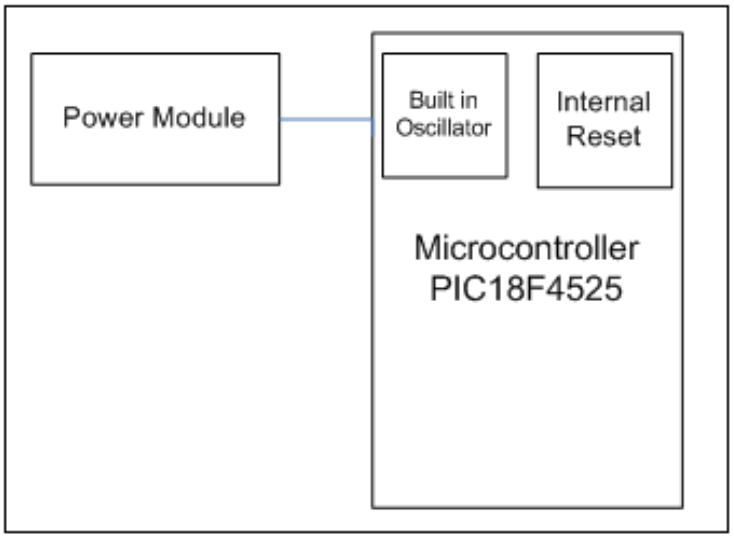

Figure 2.2: Microcontroller System Board

2.3 Input and Output Modules

The input module of the project is a 4x4 matrix keypad. The user will have to key in the IC's code by using the keypad. In order to simplify the programming, a keypad encoder is deployed to encode the signal from keypad to 4bits binary form.

The output module consists of LCD screen and audible device - beeper. The LCD screen acts as the display of the testing result while the beeper is an audible indicator of the testing result.

The IC can be classified as either input or output depends on the IC itself. Each pin can be configured as input or output, that is the connection between IC socket and PIC is bidirectional. Figure 2.3 shows the input and output modules of the project.